Nutrition in pregnancy

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INTRODUCTION

Pregnancy is a period of intense fetal growth and development, as well as maternal physiological change. Adequate intake of macronutrients and micronutrients during pregnancy promotes these processes, while undernutrition and overnutrition can be associated with adverse pregnancy outcomes [1-5]. Therefore, it is important to evaluate, monitor, and, when appropriate, make changes to improve maternal nutrition both before and during pregnancy.

The effects of inadequate or excessive intake of certain nutrients can be observed in the short-term, but possibly also in the long-term. Both fetal undernutrition and overnutrition, including development in an obesogenic environment, can lead to permanent changes of fetal metabolic pathways and thereby increase the risk of childhood and adult diseases related to these pathways. The developmental model for the origins of disease (ie, Barker Hypothesis) hypothesizes that the fetal environment causes epigenetic modifications that impact gene expression and thereby influence development of disease in children and adults [6]. Seminal studies of the health status of adult offspring of a cohort of women who were pregnant during the Dutch famine in World War II support this hypothesis [7,8].

Many questions remain unanswered due to the many challenges of performing high-quality research in pregnancy [9]. These challenges include the often unknown critical windows when nutrition may impact development, the many physiologic changes that occur over the course of normal pregnancy, the large individual differences in maternal adaptation to pregnancy, ethical and practical issues of experimenting with human pregnancy, challenges with determining effects of specific nutrients in the context of a whole diet, and the lack of a good animal model that can be directly extrapolated to humans.

This topic will discuss basic nutritional concerns related to normal pregnancy, primarily for women living in middle- and high-income countries. Nutritional therapy of diabetes in pregnant women, in-depth information on specific topics related to maternal nutrition, and basic nutritional issues in healthy nonpregnant adults are reviewed elsewhere. For example:

- (See "Healthy diet in adults".)
- (See "Vitamin supplementation in disease prevention".)
- (See "Pregestational (preexisting) diabetes mellitus: Antenatal glycemic control".)
- (See "Gestational diabetes mellitus: Glycemic control and maternal prognosis".)
- (See "Preterm birth: Risk factors, interventions for risk reduction, and maternal prognosis".)
- (See "Fish consumption and marine omega-3 fatty acid supplementation in pregnancy", section on 'Potential benefits'.)
- (See "Primary prevention of allergic disease: Maternal diet in pregnancy and lactation".)

ASSESSMENT OF NUTRITIONAL STATUS

Ideally, a woman's nutritional status is initially assessed before pregnancy so dietary changes to optimize maternal and child health can begin prior to conception [10]. Nutritional assessment and counseling should continue across pregnancy and during lactation. Where available, these activities are best performed using a team approach, which may include the obstetric provider, health professionals trained in prenatal nutrition counseling and education, and a registered dietitian with perinatal nutritional expertise. (See "Dietary assessment in adults".)

History

- **Medical and surgical** – The medical history can help uncover behaviors and medical conditions that pose nutrition-related health risks for the woman and her fetus (table 1). For example, use of cigarettes, alcohol, and illicit drugs poses direct health risks and also may affect intake of an adequate and balanced diet, while stimulants may increase energy requirements. Patients sometimes forget to disclose that they had bariatric surgery, especially if it was in the distant past. Sequelae of bariatric surgery (eg, micronutrient deficiencies, dumping syndrome) can affect pregnancy management and outcome. (See "Fertility and pregnancy after bariatric surgery".)

- **Obstetric** – The past obstetric history can impact recommendations for nutrition or supplements in future pregnancies. As an example, a past history of a neural tube defect in offspring would prompt advice to consume a higher dose of supplemental folic acid (4 mg rather than 0.4 mg) prior to conception and in early pregnancy to reduce the risk of

recurrence. (See "Folic acid supplementation in pregnancy", section on 'Either parent with a personal history of NTD or a previously affected offspring'.)

- **Dietary** – Asking the patient to complete a self-administered questionnaire is helpful for reviewing her typical diet and identifying obvious deficiencies (form 1) [11]. It is important to follow-up with specific questions about responses that suggest a possible nutritional issue. Examples of potential problems include skipping meals; limiting food; being on a special diet; consuming sweetened beverages; low frequency of consuming calcium foods, vegetables, or fruits; and high intake of foods with added sugars/fats.

  A brief screening questionnaire may be more user-friendly for health professionals in busy practices who are not specifically trained in nutrition (table 2) [11]. This questionnaire has been adapted to assess healthy eating in pregnant women and provides simple tips to improve diet quality. Although this version of the questionnaire has not been validated, a more general version has been validated for assessing diet-related chronic disease risk and has been used successfully in pregnant women [11,12].

  Women who routinely eat three meals daily that include several servings of a variety of vegetables, fruits, whole grains, low-fat dairy products, and a few sources of protein (eg, meat, poultry, seafood, beans, peas, eggs, processed soy products, nuts, seeds) likely meet the Daily Recommended Intakes for most nutrients. However, even nutrient-dense food choices and diets, such as those in the United States Department of Agriculture food patterns, may not meet nutrient goals for iron, vitamin D, and choline during pregnancy [13,14].

Physical examination — The physical examination centers on measurements of height and weight to calculate the body mass index (BMI) and assess whether the woman is at a healthy weight (calculator 1). The woman should be asked what she weighed at her last menstrual period (prepregnancy weight) and this weight should be used for baseline calculations. A prepregnancy BMI of 18.5 to 24.9 kg/m^2 is normal for Caucasian, Hispanic, and Black individuals; however, for Asians, the upper limit of normal is BMI <23 kg/m^2 [15]. BMI tables incorporating pregnancy-related changes in weight do not exist.

The remainder of the physical examination should screen for signs of nutritional deficiency or medical disease. As an example, bulimia and other eating disorders may cause enlarged parotid glands and eroded tooth enamel; anorexia can result in irregular menses, bradycardia, or dry skin. (See "Eating disorders: Overview of epidemiology, clinical features, and diagnosis".)

Physical signs of gross vitamin deficiency are still seen in areas of the world with very poor diets. In resource-rich countries, they occur in special populations, such as women with

alcoholism, malabsorption, and inborn errors of metabolism and those undergoing hemodialysis or receiving parenteral nutrition. (See "Dietary assessment in adults".)

Referrals — Consultation with a nutritionist, such as a registered dietitian, with special training in maternal nutrition is appropriate and recommended for women with special nutritional considerations, such as (table 1) [16,17]:

- Diabetes, hypertension, metabolic disorders, gastrointestinal disorders that cause malabsorption, and other conditions that respond to diet therapy.
- History of bariatric surgery or other gastrointestinal surgery affecting absorption. (See "Fertility and pregnancy after bariatric surgery".)
- Overweight and obesity, as these women are prone to excessive gestational weight gain [18].
- High intake of sweetened beverages or foods with a high level of calories from added sugars or fats (especially solid fats). Low intake of calcium-containing foods, vegetables (aside from corn and potatoes), and/or fruits.
- Food avoidances, restrictive diets, skipping meals – These practices may lead to nutritional deficiencies and inadequate gestational weight gain. (See 'Counseling women about nutrition in pregnancy' below and 'Prepregnancy weight and gestational weight gain' below.)
- Dieting history, weight fluctuations, eating disorders requiring medication or hospitalization – An eating disorder may affect fertility, become aggravated by pregnancy, or lead to pregnancy complications. (See "Eating disorders: Overview of epidemiology, clinical features, and diagnosis" and "Eating disorders: Overview of prevention and treatment" and "Eating disorders in pregnancy".)
- Multiple gestation, which requires higher gestational weight gain. (See "Triplet pregnancy", section on 'Weight gain' and "Twin pregnancy: Routine prenatal care", section on 'Gestational weight gain' and "Twin pregnancy: Routine prenatal care", section on 'Nutrition and supplements'.)
- Use of substances that may affect nutrition (eg, cigarettes, alcohol, stimulants, recreational drugs).

In addition, some women have financial constraints regarding the purchase, storage (eg, refrigerator), or preparation (eg, stove) of adequate amounts of appropriate foods. These

women require assistance from sources such as the Special Supplemental Food Program for Women, Infants, and Children or a social service agency. A short survey form to screen for food insecurity is available from the US Food and Drug Administration.

Registered dietitians who specialize in maternal nutrition can be found online at Academy for Nutrition and Dietetics website by entering the patient's or provider's zip code, selecting "Search by Expertise" and selecting "Maternal Nutrition" under the Expertise Area; however, the list is not comprehensive. For women who qualify for the Supplemental Nutrition Program for Women, Infants, and Children (WIC), nutrition counseling and education should be available at WIC appointments.

Laboratory — Hemoglobin and hematocrit are routinely checked at the first prenatal visit and in the late second/early third trimester to assess for anemia. Further evaluation is appropriate in anemic women. (See "Anemia in pregnancy", section on 'Screening during pregnancy' and "Maternal adaptations to pregnancy: Hematologic changes", section on 'Dilutional or physiologic anemia'.)

Most experts agree that it is not necessary to perform broad-based screening of serum 25-hydroxyvitamin D levels in the general population or during pregnancy [19,20]. Measurement is reasonable in pregnant women who are obese, have minimal sun exposure of skin, have a history of malabsorption (celiac disease, inflammatory bowel disease), or other risk factors for vitamin D deficiency (eg, live at northern latitudes, consume a vegan diet, dark skin). Optimal levels of 25-hydroxyvitamin D in pregnancy have not been determined, however, and this remains an active area for research. (See "Vitamin D deficiency in adults: Definition, clinical manifestations, and treatment", section on 'Monitoring' and "Vitamin D deficiency in adults: Definition, clinical manifestations, and treatment", section on 'Vitamin D replenishment'.)

PRECONCEPTION RECOMMENDATIONS

Core interventions for preconception dietary changes are discussed separately. (See "The preconception office visit", section on 'Core interventions'.)

PREGNANCY RECOMMENDATIONS

The key components of healthy eating during pregnancy include [21]:

- Appropriate gestational weight gain

- Consumption of a variety of primarily whole, unprocessed foods in appropriate amounts to allow adequate, but not excessive, gestational weight gain
- Appropriate vitamin and mineral supplementation
- Avoidance of alcohol, tobacco and other harmful substances
- Safe food handling

Because the amount of additional calories required for a typical pregnancy is small, but some nutrient requirements are relatively large, women should focus on increasing intake of high-quality, nutrient-dense foods and attempt to limit intake of processed empty-calorie foods and beverages.

Prepregnancy weight and gestational weight gain — We monitor weight gain throughout pregnancy and advise women of the National Academy of Medicine (formerly the Institute of Medicine [IOM]) recommendations for singleton pregnancy [22]:

- **Body mass index (BMI) <18.5 kg/m^2 (underweight)** – weight gain 28 to 40 lbs (12.5 to 18.0 kg)

  1 to 4 lbs (0.5 to 2 kg) over the first trimester and approximately 1 lb (0.5 kg)/week thereafter

- **BMI 18.5 to 24.9 kg/m^2 (normal weight)** – weight gain 25 to 35 lbs (11.5 to 16.0 kg)

  1 to 4 lbs (0.5 to 2 kg) over the first trimester and approximately 1 lb (0.5 kg)/week thereafter

- **BMI 25.0 to 29.9 kg/m^2 (overweight)** – weight gain 15 to 25 lbs (7.0 to 11.5 kg)

  1 to 4 lbs (0.5 to 2 kg) over the first trimester and approximately 0.5 lb (0.25 kg)/week thereafter

- **BMI ≥30.0 kg/m^2 (obese)** – weight gain 11 to 20 lbs (5 to 9.0 kg)

  1 to 4 lbs (0.5 to 2 kg) over the first trimester and approximately 0.5 lb (0.25 kg)/week thereafter

Prepregnancy BMI and gestational weight gain have independent, but cumulative, effects on infant birth weight and possibly gestational duration. The incidence of pregnancy complications is higher at the upper and lower extremes of weight gain. There is an increase in births of small for gestational age infants among women with a weight gain below the IOM's BMI-based recommendations and women who exceed the weight gain recommendations approximately

double their risk of having a macrosomic infant. Excessive gestational weight gain may also increase the risk of childhood obesity and maternal weight retention long after delivery, further supporting the IOM's recommendations for limited gestational weight gain. These relationships are discussed in detail separately. (See "Gestational weight gain".)

National data for the United States from 2012 to 2013 indicate that the prevalence of appropriate gestational weight gain (within IOM recommendations) was only 32 percent, the prevalence of inadequate gain (below IOM recommendations) was 20 percent, and the prevalence of excessive gain (above IOM recommendations) was 48 percent [18]. Excessive weight gain was particularly prevalent among overweight (62 percent) and obese (56 percent) women [18]. These data support the American College of Obstetricians and Gynecologists' (ACOG) recommendation that nutrition counseling should be offered to all overweight or obese pregnant women [4]. Women with inappropriate weight gain (inadequate or excessive) during pregnancy may benefit from nutritional counseling, as well.

Dietary recommendations — Most nutritional advice for pregnant women is based on the 1990 IOM report on nutrition in pregnancy [5], the 2009 IOM report on weight gain in pregnancy [23], the 2015 Dietary Guidelines for Americans by the United States Department of Health and Human Services and United States Department of Agriculture [24], and the 2006 IOM publication Dietary Reference Intakes: The Essential Guide to Nutrient Requirements [25]. Some dietary reference intakes have been updated since 2006, such as that for vitamin D and calcium [26], and these updated recommendations are provided in this topic.

The Recommended Dietary Allowances (RDA) are levels of nutrients recommended by an expert IOM panel based on extensive evaluation of available scientific evidence and mathematically adjusted to meet the needs of 97 percent of the population.

The following discussion applies to the general obstetric population in developed countries. Other populations may require additional nutritional considerations.

Calories — Caloric intake is a key nutritional factor in determining birth weight. Pregnant women of normal weight with a singleton pregnancy need to increase daily caloric intake by 340 and 450 additional kcal/day in the second and third trimesters, respectively, for appropriate weight gain, but do not need to increase energy intake in the first trimester (see 'Counseling about healthy eating during pregnancy' below). However, energy requirements vary by physical activity as well as age, weight, and height, so recommendations should be individualized.

In the United States, many women gain excessively during the first trimester, which often leads to excessive gestational weight gain by delivery. (See 'Prepregnancy weight and gestational weight gain' above.)

Macronutrients

Protein — The fetal/placental unit utilizes approximately 1000 g of protein during pregnancy, with the majority of this requirement in the last six months. To fulfill this need, the National Academy of Medicine recommends a dietary reference intake for pregnant women of 1.1 g/kg/day protein, which is moderately higher than the 0.8 g/kg/day recommended for nonpregnant adult women [27].

Use of special protein powders or high-protein beverages should be discouraged. In women who are undernourished, protein supplementation does not improve clinically important pregnancy outcomes [28-30]. In women who likely have adequate protein intake, there is evidence of possible harm from high-protein supplements [5,31].

Carbohydrate — Carbohydrate requirements increase to 175 g/day in pregnancy, up from 130 g/day in nonpregnant women [27]. The focus should be on consuming several servings of whole foods (fruits, vegetables, and whole grains); highly processed carbohydrates should be minimized to help manage weight gain. Fiber intake of 28 g/day is recommended for pregnant women, which, along with adequate fluid intake, may help prevent or reduce constipation.

Fat — The optimal types and quantity of fat intake in pregnancy is unclear. Variations in the quantity and type of fat intake have been associated with variations in birth weight, gestational age and length, and neurodevelopment; however, available data are limited and studies have reported mixed results [32]. (See "Fish consumption and marine omega-3 fatty acid supplementation in pregnancy" and "Preterm birth: Risk factors, interventions for risk reduction, and maternal prognosis".)

Trans fatty acids (TFA) are transported across the placenta in proportion to maternal intake. TFA may have adverse effects on fetal growth and development by interfering with essential fatty acid metabolism, by direct effects on membrane structures or metabolism, or by replacing maternal intake of the cis essential fatty acids [33]. TFA should be minimized or avoided given their adverse effects on cardiovascular outcomes, possible adverse pregnancy effects, and lack of beneficial effects. (See "Dietary fat", section on 'Trans fatty acids'.)

Lipid-based nutrient supplements (LNS) are a good source of macro- and micronutrients and have been used to address nutrient requirements in areas where maternal undernutrition is prevalent. In a systematic review of randomized trials of this intervention in nonemergency settings in low- and middle-income countries (Bangladesh, Burkina Faso, Ghana, Malawi), LNS supplementation had a slight, positive effect on weight at birth and length at birth, and a slight decrease in small-for-gestational-age and newborn stunting compared with iron/folic acid supplementation. No benefit was observed compared with multiple-micronutrient (MMN)

supplementation [34]. Data were limited, and the effect sizes were too small to draw clear recommendations for practice.

Micronutrients — Recommendations for daily intake of vitamins and minerals during pregnancy and lactation are shown in the table (table 3).

Well-nourished women may not need MMN supplements to satisfy these daily requirements, but in the absence of a careful evaluation by a nutritionist, we believe that it is prudent to recommend them. Individual adjustments should be made based upon the woman's specific needs.

MMN supplement content varies depending on the product used. At a minimum, the daily supplement should contain key vitamins/minerals that are often not met by diet alone, such as:

- Iron – 27 mg
- Calcium – at least 250 mg (elemental calcium 1000 mg/day)
- Folate – at least 0.4 mg (0.6 mg in the second and third trimesters)
- Iodine – 150 mcg
- Vitamin D – 200 to 600 international units (exact amount is controversial)

In addition to these key ingredients, pregnant women need to get adequate amounts of vitamins A, E, C, B vitamins, and zinc.

In the United States, the IOM and the Centers for Disease Control and Prevention (CDC) recommend MMN supplements for pregnant women who do not consume an adequate diet [35-37]. In high-income countries, such as the United States, groups at increased risk for micronutrient deficiencies include women carrying a multiple gestation, heavy smokers, adolescents, complete vegetarians (vegans), substance abusers, women with history of bariatric surgery, women with gastrointestinal conditions that cause malabsorption (eg, Crohn disease, bowel resection), and women with lactase deficiency. These groups may benefit from consultation with dietitians who specialize in maternal or women's nutrition (see 'Referrals' above). In the United Kingdom, the National Institute for Health and Care Excellence and Royal College of Obstetricians and Gynaecologists recommend that women take folic acid each day, from before pregnancy until the end of the first trimester, and vitamin D daily throughout pregnancy and breastfeeding; other supplements are not recommended for routine use [38,39].

In a Cochrane review of randomized trials in low- and middle-income countries where micronutrient deficiencies are high, MMN supplements in pregnancy appeared to modestly reduce rates of low birth weight (risk ratio [RR] 0.88, 95% CI 0.85-0.91) and small for gestational

age (RR 0.92, 95% CI 0.88-0.97), and possibly preterm birth (RR 0.95, 95% CI 0.90-1.01) compared with iron supplementation with/without folic acid [40]. Maternal anemia was reduced when compared with placebo but not when compared with iron supplementation with/without folic acid. There was no demonstrable benefit for several other maternal and pregnancy outcomes: miscarriage, congenital anomalies, maternal mortality, perinatal mortality. Most trials of MMNs have been conducted in low-income countries and are not generalizable to high-income countries. Because of a lack of high-quality evidence of the efficacy of MMNs in well-nourished women, national health authorities in the United Kingdom do not recommend them for all women [41,42].

Specific micronutrients are discussed in more detail below.

Iron — Iron is necessary for both fetal/placental development and to expand the maternal red cell mass. Prevalence of iron deficiency in pregnant women in the United States is estimated to be 19 percent, ranging from 7 percent in the first trimester to 30 percent in the third trimester [43]. Iron deficiency is more prevalent among Mexican-American and non-Hispanic black pregnant women, and among grand multiparous women [43].

There are two dietary forms of iron: heme and non-heme. The most bioavailable form is heme iron, which is found in meat, poultry, and fish. Non-heme iron, which comprises 60 percent of iron in animal foods and all of the iron in plant foods, fortified grains, and supplements, is less bioavailable. Absorption of non-heme iron is enhanced by vitamin C-rich foods or muscle tissue (meats, poultry and seafood) [44], and inhibited by consumption of dairy products and coffee/tea/cocoa. Dietary sources of iron are shown in the table (table 4). (See "Overview of dietary trace elements", section on 'Iron'.)

Experts recommend an increase in iron consumption by approximately 15 mg/day (to approximately 30 mg/day) during pregnancy to prevent iron deficiency anemia; this amount is readily met by most prenatal vitamin formulations and is adequate supplementation for non-anemic women. The CDC recommends that all pregnant women take a 30 mg/day iron supplement by the first prenatal visit [45]. Intermittent iron supplementation (one to three times per week) appears to be as effective as daily supplementation for preventing anemia at term and is better tolerated [46].

A 2015 systematic review for the United States Preventive Services Task Force observed that routine iron supplementation had inconsistent effects on a variety of pregnancy outcomes, but noted a consistent reduction in the frequency of iron deficiency anemia at term (RR 0.29, 95% CI 0.17-0.49; four trials) [47]. There is no strong evidence that iron supplementation in non-anemic pregnant women improves maternal or child clinical outcomes, but iron is important in fetal

brain development and it has been proposed that screening for and treatment of iron deficiency before anemia develops may benefit neurodevelopmental outcome. (See "Anemia in pregnancy", section on 'Screening for iron deficiency'.)

Women with iron deficiency anemia (first- or third-trimester hemoglobin [Hb] <11 g/dL or second-trimester Hb ≤10.4 g/dL and low serum ferritin [<40 ng/mL]) should receive an additional iron supplement (30 to 120 mg/day) until the anemia is corrected [48]. One option is 65 mg of elemental iron (325 mg ferrous sulfate) every other day [49]. Iron absorption decreases with increasing dose, thus larger supplementation amounts are best split into several doses during the day. In women who do not tolerate oral iron, iron can be administered intravenously [50-52]. Iron and folate supplementation in these women are discussed in detail separately. (See "Treatment of iron deficiency anemia in adults", section on 'Intravenous iron' and "Maternal adaptations to pregnancy: Hematologic changes", section on 'Dilutional or physiologic anemia'.)

Calcium and vitamin D — Low calcium and vitamin D levels have been associated with adverse health outcomes in mother and child, but it is unclear whether low levels are the causal factor or a marker of poor health. These issues are discussed in detail separately. (See "Clinical manifestations, diagnosis, and treatment of osteomalacia", section on 'Pregnancy' and "Vitamin D and extraskeletal health", section on 'Pregnancy outcomes' and "Vitamin D deficiency in adults: Definition, clinical manifestations, and treatment", section on 'Pregnancy'.)

- **Calcium** – Fetal skeletal development requires approximately 30 grams of calcium during pregnancy, primarily in the last trimester. This total is a relatively small percentage of total maternal body calcium and is easily mobilized from maternal stores, if necessary. Intestinal absorption and renal retention of calcium increase progressively throughout gestation [53].

  The RDA for elemental calcium is 1000 mg/day in pregnant and lactating women 19 to 50 years of age (1300 mg for girls 14 to 18 years old) [54]. The dietary recommendation for calcium is the same for nonpregnant women of the same age. The Dietary Guidelines Scientific Report estimated that 24 percent of United States pregnant women consume less than 800 mg/day [55]. Calcium content of selected foods can be found online from the United States Department of Agriculture (USDA) National Nutrient Database.

  For women with low baseline dietary calcium intake (particularly in non-United States populations), high-dose calcium supplementation may reduce the risk of developing a hypertensive disorder of pregnancy [56]. Calcium supplementation does not appear to reduce this risk in healthy, nulliparous women in whom baseline dietary calcium intake is adequate. Although there may be a benefit for preeclampsia prevention in high-risk

populations, further study is required since available information is based upon small numbers of women and diverse study populations.

In a 2015 systematic review, calcium supplementation did not reduce the risk of spontaneous preterm birth or low birth weight [57].

- **Vitamin D** – For routine supplementation, the 2010 IOM report suggests an RDA of 600 international units of vitamin D for all reproductive-age women, including during pregnancy and lactation [58]. In a 2011 ACOG committee opinion, ACOG recommended routine supplementation with the dose in a standard prenatal vitamin until more evidence is available to support a different dose [20]. Most prenatal vitamins contain 400 international units of vitamin D, but some preparations contain as little as 200 or as much as 1000 to 1200 international units.

  Many commercial nonprescription products labeled "vitamin D" (multivitamin supplements, fortified milk, and bread) contain ergocalciferol (D2) rather than cholecalciferol (D3). D3 is more readily converted to active forms of vitamin D and is more effective at increasing serum 25-hydroxyvitamin D. Supplements often specify the type of vitamin D they contain. Most prescription prenatal vitamins contain D3, but some contain D2, and some contain a mixture.

  The safe upper limit of vitamin D has not been well studied but was conservatively set at 4000 international units in the most recent 2011 guidelines [59]. Since then, studies have investigated high-dose supplements in pregnant patients. These studies have had relatively small sample sizes and have evaluated potential benefits, such as reduced incidence of autism (up to 5000 international units daily to achieve 25-hydroxyvitamin D levels between 40 and 60 ng/mL), preeclampsia (up to 4000 international units daily to achieve 25-hydroxyvitamin D levels at least 32 ng/mL), and asthma (4400 international units daily to achieve 25-hydroxyvitamin D at least 30 ng/mL) [60-62]. Notably, no adverse events have been observed at these high doses of vitamin D.

The value of routine vitamin D supplementation above the RDA in pregnancy is an active and controversial area of investigation, but there is no clear evidence of a reduction in adverse pregnancy outcomes (eg, preeclampsia, stillbirth) or several adverse offspring outcomes (eg, neonatal death, allergy, low bone mineral content). Meta-analyses of randomized trials of vitamin D supplementation during pregnancy have found reduced risks of birth of a small for gestational age infant (RR 0.72, 95% CI 0.52-0.99) [63] and wheeze/asthma in offspring (odds ratio 0.72, 95% CI 0.56-0.92) [64]. However, the magnitude of the favorable effect on birth weight varied widely and may be clinically insignificant [63]. Insignificant effects on

eczema/atopic dermatitis and food allergies were also noted [64]. There was no increase in risks of fetal or neonatal mortality or congenital abnormality [63].

The trials differed in several aspects, such as the population studied, outcomes chosen, clinical setting, timing of the intervention, and the dose of vitamin D administered during pregnancy. More rigorous and sufficiently large randomized trials in women with and without vitamin D deficiency are needed to confirm the effects of vitamin D supplements above the RDA on pregnancy outcomes. Additional data are presented and reviewed separately. (See "Vitamin D deficiency in adults: Definition, clinical manifestations, and treatment", section on 'Pregnancy'.)

Folic acid

For neural tube defect prevention — The United States Preventive Services Task Force recommends that women take a supplement containing 0.4 to 0.8 mg of folic acid one month before and for the first two to three months after conception to reduce their risk of having a child with a neural tube defect [65,66]. An RDA of 0.6 mg is recommended thereafter to meet the growth needs of the fetus and placenta [35]. Continuing folic acid supplementation after the first trimester prevents the decline in serum folate and rise in homocysteine concentrations that occur when supplementation is discontinued [67].

Although most women in the United States take folic acid-containing supplements during pregnancy, the proportion taking them during the first trimester is lower (55 to 60 percent) than that during the second (76 to 78 percent) or third (89 percent) trimesters [68]. Non-supplement users were more likely to be under 25 years old, have less education, and be unmarried compared with supplement users. Thus, women with these characteristics may benefit from emphasis on the importance of taking folic acid preconception and in the first trimester.

Folic acid recommendations are higher for women in certain high-risk groups, which are reviewed separately. Issues related to folic acid intake and supplementation in pregnancy, including nutritional sources of folic acid (fortified foods) and folate (citrus, dark green leafy vegetables, nuts, liver (table 5)) and their role in prevention of neural tube defects, are reviewed in detail separately. (See "Folic acid supplementation in pregnancy".)

Other potential benefits — In individual trials, folic acid supplementation, usually as part of a multivitamin, has been associated with a variety of benefits unrelated to neural tube defects, but these relationships require further study and confirmation. (See "Folic acid supplementation in pregnancy", section on 'Does folic acid supplementation improve other pregnancy outcomes?'.)

Choline — Choline is an essential nutrient that is transported at high rates from mother to fetus. Choline availability is crucial for the development of the central nervous system, with evidence of effects on cognitive function in infants [69]. Most United States women consume far less choline (mean intake 260 mg/day) than the 450 mg/day that is recommended [70].

Pregnant women should consume adequate choline from food and supplemental sources, although choline in often absent or low in prenatal vitamins. Eggs, meats, fish, and dairy are good sources of choline; plant sources, such as navy beans, Brussels sprouts, broccoli, and spinach also contain choline [69].

Zinc — Zinc is essential for normal growth, severe zinc deficiency has been associated with growth restriction, and observational studies have suggested that zinc supplements can increase birth weight [71]. However, a 2015 systematic review of 21 randomized trials of zinc versus no zinc supplementation in pregnancy found that zinc supplementation did not improve any pregnancy outcome, except for a 14 percent reduction in preterm birth in trials that primarily involved low-income women (RR 0.86, 95% CI 0.76-0.97) and without a statistical reduction in low birth weight (RR 0.93, 95% CI 0.78-1.12) [72]. Multiple social, nutritional, and medical factors may have been responsible for the preterm births in low-income women and these issues are probably more important targets for intervention than zinc intake.

Contemporary data for zinc intake among pregnant women in the United States are not available; the last report by the National Health and Nutrition Examination Survey 1988 to 1994 indicated a mean intake of 9 mg/day from food alone, and a total intake of 22 mg/day from food plus supplements, which meets and safely exceeds the requirement [73].

Management of women who are at risk for severe zinc deficiency (eg, active inflammatory bowel disease, acrodermatitis enteropathica, pica) is discussed separately. (See "Zinc deficiency and supplementation in children".)

Iodine — Iodine deficiency has potentially harmful effects, such as maternal and fetal/neonatal hypothyroidism. The National Academy of Medicine recommends daily iodine intake of 220 mcg during pregnancy and 290 mcg during lactation; the World Health Organization (WHO) recommends iodine intake of 250 mcg for both pregnant and lactating women.

United States data suggest that, among pregnant women, 23 to 56 percent have inadequate intake based on urinary iodine concentrations [74,75]. Similar results have been found in the United Kingdom and in Sweden [76].

Declining intakes of iodine may be related to increased intake of non-iodized salt from processed foods and in the home (such as sea salt, which contains less iodine than iodized salt). Pregnant women should be encouraged to use iodized salt (contains 95 mcg iodine per one-quarter teaspoon) and/or consume seafood that is naturally rich in iodine to attain adequate intake. A Cochrane systematic review found insufficient data to reach any clinically useful conclusions on the benefits and harms of routine iodine supplementation preconception, during pregnancy, or postpartum [77]. Another systematic review came to a similar conclusion regarding iodine supplementation for pregnant women residing in areas of mild-to-moderate iodine deficiency [78], presumably because they are able to physiologically adapt to mildly low iodine intakes and draw from intrathyroidal iodine stores to maintain fetal euthyroidism and enable normal neurodevelopment [79]. However, given the lack of definitive data, the American Thyroid Association recommends that women who are planning pregnancy, are pregnant, or are lactating supplement their diet with a daily oral multivitamin supplement that contains 150 mcg of iodine in the form of potassium iodide [80]; it should be noted that many prenatal vitamins contain no iodine [81].

Excessive iodine intake is also harmful (discussed below).

Vitamin A — Vitamin A requirements increase slightly during pregnancy, from 2640 international units (800 retinol equivalents) per day in nonpregnant women to 3300 international units (1000 retinol equivalents) per day in pregnant women, because of its role in cell division, fetal organ and skeletal growth, maintenance of the immune system, and development of vision in the fetus as well as maintenance of maternal vision [82]. A pregnant woman with moderate deficiency is at higher risk for night blindness, particularly in the third trimester when fetal growth is accelerated, because the fetus will obtain sufficient vitamin A at the expense of maternal stores [82-84]. In some developing countries, vitamin A deficiency is a concern; in addition to maternal night blindness, deficiency puts women at risk of maternal xerophthalmia, anemia, and susceptibility to infection [85]. By contrast, in developed countries, excessive intake of vitamin A is the primary concern. (See 'Adverse effects from excessive supplementation and dietary intake' below.)

Where vitamin A deficiency is endemic, such as Southeast Asia and sub-Saharan Africa, a daily supplement less than 10,000 international units (3000 retinol equivalents) or a weekly supplement less than 25,000 international units (8500 retinol equivalents) appears to have some maternal and fetal/neonatal health benefits (eg, reduction in maternal anemia and night blindness) with no evidence of teratogenicity [86,87], but does not reduce maternal or perinatal mortality [88], which was suggested by some early studies. Vitamin A supplementation is

unnecessary where habitual vitamin A intake exceeds three times the RDA (ie, 8000 international units or 2400 mcg retinol equivalents).

Adverse effects from excessive supplementation and dietary intake — The use of self-prescribed supplements is commonplace and has led to numerous case reports of vitamin or mineral toxicities due to overuse of over-the-counter medicines. Excessive maternal consumption of specific foods can also be potentially toxic to the fetus.

- Vitamin A – Excessive intake of vitamin A affects the developing embryo and can be teratogenic. In the absence of severe deficiency, pregnant women should avoid multivitamin or prenatal supplements that contain more than 5000 international units (1500 retinol equivalents) of vitamin A. Most supplements contain beta-carotene rather than retinol, and high beta-carotene intakes have not been related to birth defects [89]. Consumption of vitamin supplements containing high doses of vitamin A (greater than 10,000 international units per day [1 international unit = 0.3 retinol equivalents]) appears to be teratogenic [86,90].

  Some foods are fortified with vitamin A and others are rich in vitamin A (eg, liver). For this reason, some groups (eg, Finnish Food Safety Authority Evira, National Health Service) recommend avoiding liver consumption during pregnancy [91-96]. Limiting the intake of liver and liver products during the first trimester is likely prudent, particularly in high-income countries where vitamin A deficiency is rare.

  For women who commonly consume liver, we advise checking local food composition databases as vitamin A content of livers from different animals vary. For example, in the United States Department of Agriculture Nutrient Database [97], vitamin A content of liver and liver products vary from 4900 international units in one raw chicken liver to 59,500 international units in 3 ounces of cooked New Zealand beef liver.

- **Iodine** – Excessive intake of iodine can cause fetal goiter [98-100], but the safe upper limit of iodine intake in pregnancy is unclear. Fetal hypothyroidism has been reported in women ingesting 12.5 mg iodine daily [98] and 2.3 to 3.2 mg of iodine daily [100]. Excessive dietary iodine intake has been reported in Japanese women whose diets contain large amounts of seaweed [100]. One study among women in the United States suggests that excessive intake as estimated by urinary iodine is quite uncommon at <1 percent [75].

Supplements that lack beneficial effects

- **Vitamin E** – A Cochrane review showed that vitamin E supplementation during pregnancy in combination with vitamin C or other supplements or drugs does not improve outcomes

of stillbirth, preterm birth, preeclampsia or low birth weight [101]. Some evidence suggested that vitamin E increased self-reported abdominal pain and prelabor rupture of membranes at term; however, preterm prelabor rupture of membranes was not increased.

- **Vitamin C** – In a Cochrane review, vitamin C supplementation during pregnancy either alone or in combination with other supplements had no beneficial or harmful effects [102]. No effects were observed on prevention of stillbirth, preterm birth, preeclampsia, or low birth weight. Vitamin C supplementation alone resulted in a decreased risk of preterm prelabor rupture of membranes, however, the quality of evidence was poor.

Fluid requirements — During pregnancy, adequate fluid intake from consumption of beverages (water and other liquids) is estimated to be approximately 2.3 L/day (76 fl oz or approximately 10 cups), per the National Academy of Medicine [103]. Additional water is consumed in foods other than beverages to meet the total adequate intake of 3 L/day. Numerous factors (eg, ambient temperature, humidity, physical activity, exercise influence) also influence total water needs.

COUNSELING WOMEN ABOUT NUTRITION IN PREGNANCY

Health care professionals have an important role in assessing and counseling women about nutrition to promote optimal outcomes for pregnancy. Providers who monitor gestational weight gain have key opportunities to provide information and tools to help women. In a 2014 systematic review of 25 studies in developed countries, women reported that they received inadequate nutrition information from health care professionals [104]. Importantly, the same review found that women who received nutrition information from their health care professionals were more likely to comply with advice when it was specific and explanations were provided for the recommendations. Furthermore, women were more likely to take prenatal supplements if it was verbally recommended by their provider and they received ongoing counseling at subsequent visits. Thus, health care professionals have the potential to impact the nutritional status of pregnant women.

Counseling about healthy eating during pregnancy — Women who are pregnant should eat plenty of fruits and vegetables as well as whole grains, low-fat dairy, and a variety of proteins. The exact amount of foods from each food group (ranges provided below) needed by a woman depends on her prepregnancy body mass index (BMI), activity level, age, and trimester. It is important for pregnant women to choose foods that are nutrient-dense (foods that contain high levels of important nutrients compared with the amount of calories, such as fruits and vegetables, nuts/nut butters, yogurt) to meet the higher nutrient requirements in pregnancy

without exceeding caloric needs. Women should also avoid foods with empty calories (foods that are high in added sugars and solid fats, such as soda, desserts, fried foods, whole-fat dairy, and high-fat meats) because they provide little nutritional value beyond calories.

Use of a nutrition screening tool can help health professionals identify pregnant women who may be at risk for lower quality diets. (See 'History' above.)

In the first trimester of pregnancy, women typically do not need to increase their caloric intake. In the second and third trimesters, most women will need to increase their caloric consumption to promote appropriate weight gain. However, the old adage "eating for two" neither accurately nor appropriately depicts the increased needs of pregnant women. Energy requirements for pregnancy differ by BMI class. Normal-weight women need only approximately 340 and 450 additional kcal/day in the second and third trimesters, respectively [105]. It has been estimated that overweight women require an additional 260 to 360 kcal/day [106], and data have been inadequate to make clear recommendations for obese women [107].

Most pregnant women in the last two trimesters will require between 2200 and 2900 kcal/day [107], although caloric needs can vary widely and this should be assessed individually. The ranges of number of servings for each food group needed to meet these caloric requirements (2200 to 2900 kcal/day) are:

- Fruits – 2 to 2.5 cups
- Vegetables – 3 to 3.5 cups
- Grains – 6 to 10 oz
- Protein – 6 to 7 oz
- Dairy – 3 cups

Online resources — Online information is available at:

- Maternal diet
- Patient education material ("Tips for Pregnant Moms")

Counseling about common dietary concerns in pregnancy — Self-imposed dietary restraints can be problematic if essential nutrients are left out of the diet or weight gain is inadequate. However, certain foods should be limited or avoided during pregnancy because of potentially toxic effects. These include:

- Consumption of some types of fish
- High caffeine intake
- Unwashed fruits/vegetables

- Unpasteurized dairy products
- Undercooked meats

These issues and others are discussed below.

Vegetarian diet — Balanced vegetarian diets do not appear to have any adverse effects on pregnancy outcome, although high-quality evidence is sparse [108,109]. These diets vary considerably, as do omnivorous diets. The nutritional adequacy of a vegetarian diet must be judged individually, not on the basis of what it is called, but on the type, amount, and variety of nutrients that are consumed [110].

Vegetarian diets that are well-balanced are similar to well-balanced omnivore diets in that they meet most nutrient goals except for iron, vitamin D, vitamin E, and choline [14,111]. Additional potential nutrients of concern, particularly for vegans, are calcium, vitamin B12, and essential n-3 fatty acids (eicosapentaenoic acid [EPA] and docosahexaenoic acid [DHA]). In one review, women on a vegan diet were at higher risk for both iron and vitamin B12 deficiencies [109].

Dietary deficiencies can usually be resolved with minor dietary alterations or supplements. For example, fortified vegetarian/vegan food products are now widely available and include some nondairy milks (such as fortified soy beverages), meat analogs, and breakfast cereals. These products can be good sources of key nutrients, such as calcium, iron, zinc, vitamin B12, vitamin D, riboflavin, and long-chain n-3 fatty acids. Individual nutritional assessment of a vegetarian's diet with a registered dietitian is advisable [108,112-114].

Vegetarian diets vary according to the degree of avoidance of foods of animal origin [115]. According to the strictest definition, a vegan vegetarian diet consists primarily of cereals, fruits, vegetables, legumes, and nuts; animal foods, including milk, dairy products, and eggs generally are excluded [116,117]. Several less restrictive vegetarian diets may include animal flesh, eggs, or milk and dairy products. Vegetarian diets frequently are grouped as follows (ordered from less restricted to more restricted):

- **Semi-vegetarian** – People who consume meat, fish or chicken in their diet on occasion. Some people who follow such a diet may not eat red meat, but may eat fish and perhaps chicken. This identification is used mainly in research studies.

- **Pescatarian** – Vegetarian whose diet includes fish on occasion in addition to eggs, milk, and milk products, but no other animal meats.

- **Lacto-ovovegetarian** – Eggs, milk, and milk products (lacto = dairy; ovo = eggs) are included, but no meat is consumed.

- **Lactovegetarian** – Milk and milk products are included in the diet, but no eggs or meat are consumed.
- **Macrobiotic** – Whole grains, especially brown rice, are emphasized and vegetables, fruits, legumes, and seaweeds are included in the diet. Locally-grown fruits are recommended. Animal foods limited to white meat or white-meat fish may be included in the diet once or twice a week.
- **Vegan** – All animal products, including eggs, milk, and milk products, are excluded from the diet. Some vegans do not use honey. They also may avoid foods that are processed or not organically grown [118].
- **Fruitarian** – Vegan diet based on fruits, nuts and seeds. Vegetables classified botanically as fruits (avocado, tomatoes) are commonly included in fruitarian diets; all other vegetables, grains, beans and animal products are excluded.

Limited research in populations outside of the United States showed that the macronutrient intake of pregnant vegetarians was similar to that of pregnant non-vegetarians except pregnant vegetarians consumed statistically lower amounts of protein and higher amounts of carbohydrate than pregnant non-vegetarians; however, none of the studies reported protein deficiency in pregnant vegetarians [119,120].

Protein quality in well-balanced vegetarian diets need not be a concern. Although individual plant sources of protein tend to be incomplete in their provision of all essential amino acids, eating a variety of types of plant protein sources (grains, legumes, nuts) over the course of a day can provide all essential amino acids [108].

Protein consumption in the United States tends to be significantly higher than in other parts of the world. In some Asian cultures, animal protein sources may be consumed only once or twice a week. Although these individuals would not label themselves as vegetarian, in American research studies they would be categorized as semi-vegetarian.

Phytoestrogen consumption tends to be higher among vegetarians than among omnivores. Concerns have been raised regarding phytoestrogen intake and reproductive development. Studies have reported conflicting effects of prenatal exposure to phytoestrogens. A prospective study first reported an increased risk of hypospadias in offspring of vegetarian women [121]; however, subsequent research found no correlation [122]. At this time, evidence does not support an association between vegetarian diets and risk of disrupted reproductive development [123].

Food avoidance/consumption to prevent atopic disease in offspring — Both avoidance and ingestion of specific antigens, such as peanuts, milk, and eggs, during pregnancy have been hypothesized to reduce the frequency of atopic disease in offspring, but the bulk of evidence does not support either approach. These diets should not be recommended; women should consume their usual diets. (See "Primary prevention of allergic disease: Maternal diet in pregnancy and lactation".)

On the other hand, breastfeeding may reduce the risk of allergic disease in offspring. (See "The impact of breastfeeding on the development of allergic disease".)

Gluten-free diet — Although gluten-free diets are popular and promoted in the lay press for their health benefits, there is no evidence that following a gluten-free diet has any significant health benefits in women without celiac disease or gluten sensitivity [124,125]. Elimination of gluten-rich foods during pregnancy could result in inadequate intakes of thiamin, riboflavin, niacin, folate, and iron; however, substitution of other whole grain foods and folic acid supplementation should prevent any nutritional deficiency and these diets are generally considered safe.

Women with celiac disease benefit from a gluten-free diet. In a systematic review of case-control and cohort studies, women with untreated celiac disease were at increased risk of reproductive failure compared with women in the general population [126]. Treatment with a gluten-free diet eliminated the excess risk of complications. (See "Epidemiology, pathogenesis, and clinical manifestations of celiac disease in adults", section on 'Menstrual and reproductive issues'.)

Low carbohydrate diet — Nonpregnant women may choose to follow a "low carb" diet for a variety of reasons. In a review of data from the National Birth Defects Prevention Study, the folic acid intake of women with restricted carbohydrate intake was less than half that of other women, and they appeared to be at slightly increased risk of having an infant with a neural tube defect (NTD; odds ratio 1.30, 95% CI 1.02-1.67) [127]. A subsequent study using pre-food fortification data also noted this association between low carbohydrate diets and NTDs, thus suggesting that the increased risk may not be related solely to low folic acid intake in the post-fortification era [128]. Although a causal role between restricted carbohydrate intake (≤5th percentile or 95 g/day) and NTDs has not been established, for women who follow low carbohydrate diets, it is prudent to emphasize the importance of the standard recommendation that all women take a 0.4 to 0.8 mg folic acid supplement one month before and for the first two to three months after conception. Further investigation between low carbohydrate diets and NTDs is needed. (See 'Folic acid' above.)

The ketogenic diet is one type of low carbohydrate diet, classically consisting of high-fat, adequate-protein, low-carbohydrate consumption that produces metabolic changes associated with the starvation state. These diets were originally developed as a treatment for epilepsy in childhood but are now being used by some adults with epilepsy and by the general population as a method of weight control. These diets can be either hypocaloric or normocaloric and can be used in combination with other types of diets [129]. There is minimal information on the fetal effects of the diet on human pregnancy [130,131], which is concerning since maternal changes in plasma ketones, insulin, glucose, glucagon, and free fatty acids can be quite profound. Some rodent studies have reported potentially adverse fetal effects, such as fetal overgrowth and structural changes in the brain [132,133].

Paleolithic diet — The "paleo" diet generally includes nuts, fish, meat, eggs, and some fruits and vegetables and excludes dairy, grain-based foods, legumes, refined sugar, table salt, and processed foods [134]. It tends to be high in protein, moderate in fat (mainly unsaturated fats), low to moderate in carbohydrates, and low in sodium. It also tends to be low in certain types of fiber and calcium due to the exclusion of grains, legumes, and dairy [135,136]. One study among nonpregnant women reported a rise in iodine deficiency after six months of consuming a paleo diet [137]. Little information is available in pregnant women. In one retrospective cohort study comparing 37 women with low-risk pregnancies who adhered to this diet before and throughout gestation with 39 similar low-risk women who consumed a regular diet, the paleo diet was associated with lower glucose challenge test scores (95.8 versus 123.1 mg/dL), higher hemoglobin levels (12.10 versus 11.05 g/dL) and ferritin (32.1 versus 21.3 mg/mL), lower gestational weight gain (9.3 versus 10.8 kg), and lower birth weight (3098 versus 3275 g), with no differences in adverse neonatal outcomes [138].

We suggest that women on paleo diets take prenatal vitamins with at least 400 to 800 mcg of folic acid and 150 to 250 mcg of iodine (if they do not consume iodized table salt). Calcium supplements of 1000 mg divided into 2 or 3 doses throughout the day are also recommended. (See 'Micronutrients' above.)

Lactose intolerance — Women with lactose malabsorption have improved lactose tolerance in late pregnancy [139,140]. This has been attributed to slower intestinal transit during pregnancy and bacterial adaptation to increased lactose intake.

Women who are unable to consume adequate amounts of calcium through dairy and other dietary components can take calcium supplements or consume calcium fortified foods and beverages. There are no data on the safety of commercially available "lactase" preparations during pregnancy; however, beta-galactosidases are normal constituents of human tissues. (See "Lactose intolerance: Clinical manifestations, diagnosis, and management".)

Use of non-nutritive sweeteners — Intake of non-nutritive sweeteners is common and has increased dramatically among pregnant women in the United States over the last decade [141,142]. Although clinical studies on the short- and long-term effects of consumption of these substances during pregnancy are limited, no data suggest that use of aspartame (NutraSweet, Equal), sucralose (Splenda), saccharin (Sweet'N Low), acesulfame potassium (Sunett, Sweet One), or stevioside (Stevia, Truvia, SweetLeaf) by pregnant women increases the risk of birth defects above the baseline risk in the general population [143]. However, other issues, including increased infant BMI, childhood obesity, a small increase in preterm birth, and an altered childhood preference for sweet taste, have been observed, and the effects appear to be independent of overall diet quality, energy intake, or other obesity risk factors [144-150].

The Acceptable Daily Intake (ADI) is defined as an estimate of the amount of a food additive that can be ingested daily over a lifetime without appreciable health risk. Average use of non-nutritive sweeteners is usually below this limit. For example, the ADI for aspartame is 50 mg/kg/day; Diet Coke contains 131 mg aspartame per 355 mL can and one packet of Equal contains 33 mg of aspartame. The ADI for saccharin and sucralose is 5 mg/kg/day, for acesulfame potassium it is 15 mg/kg/day, and for stevioside it is 4 mg/kg/day.

Saccharin, acesulfame, and sucralose cross the placenta whereas aspartame does not because it is fully digested in the gastrointestinal tract [151]. The US Food and Drug Administration (FDA), which regulates nutritive and non-nutritive sweeteners in the United States, has deemed acesulfame potassium, advantame, aspartame, neotame, saccharin, luo han guo fruit extract, >95 percent purity steviol glycosides, and sucralose to be safe for use by the general public, including during pregnancy [152].

An overview of issues related to use of non-nutritive sweeteners is available separately. (See "Overview of non-nutritive sweeteners".)

Sugar-sweetened beverages — Pregnant women should be advised to avoid or limit sugar-sweetened beverages for the health of both the mother and her child.

More than occasional intake of sugar-sweetened beverages is generally discouraged in all populations because these drinks tend to be high in calories and low in nutritive value. Concerns have also been raised about consumption of these beverages in pregnancy. In a prospective prebirth cohort study, sugar-sweetened beverage intake was associated with increased adiposity in school-aged offspring [153]; for each additional serving of a sugary beverage consumed by a mother during the second trimester there was a 0.15 kg/m^2 (95% CI -0.01 to 0.30) increase in fat mass [153]. The association persisted after adjustment for multiple confounding variables and was independent of the offsprings' beverage intake. No such

association was found for maternal intakes of diet soda or water. These findings add to a growing body of data supporting prenatal programming of susceptibility to obesity.

Others have reported an association between maternal sugary beverage intake and preeclampsia [154] and conflicting findings regarding maternal sugary beverage intake and risk of preterm birth [149,155].

Fluoride intake — Theoretically, pregnant women who live in areas where water is not fluoridated or who consume only unfluoridated bottled water may not achieve adequate intake of fluoride, which is 3 mg/day in nonpregnant, pregnant, and breastfeeding women [156,157]. Fluoride intake is difficult to determine, given that fluoride may be present in liquids used for bottled drinks and prepared foods (eg, soups, canned vegetables) and is present in tea and seafood that contains edible bones or shells.

The CDC does not recommend fluoride supplementation during pregnancy [158] because prenatal fluoride supplementation is not incorporated into primary teeth [159] and did not reduce caries in offspring in the only randomized trial of this intervention [160,161]. The benefits of fluoride occur almost entirely after tooth eruption as a direct topical effect on teeth; earlier hypotheses that ingested fluoride is systemically incorporated into developing tooth enamel have been largely discredited as a primary mechanism of fluoride action [162,163]. There is good evidence that postnatal exposure of newly erupted teeth to topical fluoride from water or dentifrice is efficacious [162,163].

Excessive ingestion of fluoride during pregnancy does not appear to produce fluorosis in offspring [164]. Although fluoride readily crosses the placenta, the placenta may provide a partial barrier to transfer of excess fluoride when maternal levels are high [165]. However, a possible association with neurodevelopmental effects has been reported in ecological studies in China and Mexico and a multicenter birth cohort study in Canada [166-169]. The source of fluoride in the Canadian and Mexican studies was optimally fluoridated water consumed as tap water and other water-based beverages. The Canadian study also adjusted for consumption of tea, which has a high fluoride content. The source of fluoride in the Chinese study was well water; there was no adjustment for tea consumption. The observed association may be related to bias, imprecision, and unmeasured confounding; further investigation is warranted before fluoride can be considered a neurodevelopmental toxicant [170]. (See "Overview of dietary trace elements" and "Preventive dental care and counseling for infants and young children".)

Fasting — Pregnant women may fast for several hours during the day, for one or more days, for religious or other reasons. During an overnight 12- to 18-hour fast, plasma glucose, insulin, and alanine levels fall, and plasma-free fatty acids and beta-hydroxybutyrate levels rise, a

phenomenon termed "accelerated starvation" [171]. With early conversion to fat metabolism, other fuels, such as glucose and amino acids, are more available for the fetus. Free fatty acids and beta-hydroxybutyrate are also transferred across the placenta and metabolized by the fetus.

The effects of daytime fasting in otherwise healthy pregnant women are not well-defined. In ovine and human studies, the most consistently reported effect of fasting is reduction in fetal breathing movements, with resolution in the fed state [172-176]. There is no information on the effect of ketonuria on fetal/neonatal outcome in the absence of ketoacidosis. Studies of short-term pregnancy outcome in healthy women who fasted during the month of Ramadan (during which fasting occurs from sunrise to sunset) have generally reported no adverse effects on the fetus or uterine blood flow [177-183]. However, a longer-term study reported that exposure to Ramadan in early pregnancy may have adverse effects on childhood mortality [184]. In this study of 20 years of data from Burkina Faso, when Ramadan occurred during conception, the first trimester, or the second trimester, the under-age-5 mortality rates of children born to Muslim mothers were 33, 29, and 22 percent higher, respectively, than in children of non-Muslim mothers born at the same time. Childhood mortality in offspring of Muslim mothers was not increased with exposure during the third trimester or in the absence of in utero exposure. However, it should be noted that most of the population of Burkina Faso lives by subsistence farming and has seasonal food insecurity and the women may have been nutritionally deprived in addition to fasting; many young children are chronically nutritionally deprived. Thus, the findings in this study may not apply to Muslim women in other countries where food insecurity is not prevalent. Other lifestyle changes also occur during Ramadan, such as increases in fat and sugar consumption, which may also play a role in the observed association.

Some authors have hypothesized that prolonged fasting during pregnancy can lead to permanent alterations in fetal physiology, consistent with fetal programming, that have consequences in adult life [185]. Further study of the potential long-term effects of fasting at various times during pregnancy and in high- as well as low-resource regions are needed.

Long-chain polyunsaturated fatty acids — Fish is the primary dietary source of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), two n-3 (also known as omega-3) long-chain polyunsaturated fatty acids (n-3 LCPUFA). DHA is necessary for normal development of the brain and retina. The body's ability to produce sufficient DHA for optimal health and development is probably inadequate; therefore, consumption of preformed n-3 LCPUFA, such as in fish, is recommended. The number of weekly servings of fish needed to achieve the DHA intake goal of 200 to 300 mg/day depends on the type of fish, as shown in the table (table 6).

Importantly, women of childbearing age should choose fish that are low in mercury and other contaminants (table 7). (See 'Fish consumption' below.)

For pregnant women who are not able or willing to consume fish, we suggest other food sources of n-3 LCPUFA to achieve an intake of 200 to 300 mg/day of DHA. A number of foods fortified with DHA are available, including yogurt, milk, and eggs. Supplements containing either fish oil or DHA synthesized by algae are also available. Some prenatal vitamins also contain DHA/EPA. The potential benefits of n-3 LCPUFA supplementation on pregnancy outcome are not clearly established; available data are discussed in detail separately. (See "Fish consumption and marine omega-3 fatty acid supplementation in pregnancy".)

Probiotics — Consumption of probiotic supplements is increasingly popular. Some evidence suggests that probiotic use (combinations of certain Lactobacillus and *Bifidobacterium* strains) during pregnancy may have beneficial maternal effects, such as reduced risk of inflammatory events and preeclampsia and improved maternal glucose metabolism [186,187].

Studies of probiotic use during pregnancy have not reported increased risk of adverse fetal outcomes, but data are limited [188]. A 2018 Cochrane review did not find appreciable benefit or harm to neonates as a result of oral probiotic supplementation of pregnant women at low risk for preterm birth or mothers of preterm infants after birth [189].

Food safety

Avoidance of foodborne infections — Foodborne illnesses can cause maternal disease as well as congenital disease, miscarriage, premature labor, and fetal death. To reduce the risk of foodborne illness, it is important that pregnant women [190]:

- Practice good personal hygiene (frequent hand washing).
- Consume only meats, fish, and poultry (including eggs) that are fully cooked.
- Avoid unpasteurized dairy products and fruit/vegetable juices.
- Thoroughly rinse fresh fruits and vegetables under running water (approximately 30 seconds) before eating.
- Avoid eating raw sprouts (including alfalfa, clover, radish, and mung bean). Bacteria can get into sprout seeds through cracks in the shell; these bacteria are nearly impossible to wash out.

- Wash hands, food preparation surfaces, cutting boards, dishes, and utensils that come in contact with raw meat, poultry, or fish with hot, soapy water. Countertops can be sanitized by wiping with a solution of one teaspoon liquid chlorine bleach per quart of water and leaving to dry over 10 minutes.

The FDA provides detailed advice on food safety for women who are pregnant or planning pregnancy.

The following foodborne infections can have adverse effects on pregnancy. These infections and strategies for avoiding them are described in detail separately:

- **Toxoplasmosis** – Toxoplasmosis is caused by ingestion of undercooked or cured meat or meat products, fruit or vegetables contaminated by infected soil, and contaminated unfiltered water. (See "Toxoplasmosis and pregnancy".)

- **Listeria monocytogenes** – Listeria is a common low-level contaminant of both processed and unprocessed foods of plant and animal origin; hot cooked foods are not a vehicle of Listeria transmission. It is most commonly associated with processed/delicatessen meats, hot dogs, soft cheeses, smoked seafood, meat spreads, and pâté, but has also been transmitted by fresh fruits and vegetables that are commonly eaten uncooked. (See "Clinical manifestations and diagnosis of Listeria monocytogenes infection".)

- **Brucellosis** – Brucellosis is caused by ingestion of contaminated food such as raw milk, cheeses made from unpasteurized (raw) milk, or raw meat. (See "Brucellosis: Epidemiology, microbiology, clinical manifestations, and diagnosis".)

Information about current foodborne illness outbreaks can be found at the Centers for Disease Control and Prevention website.

Fish consumption — Pregnant women are advised to eat only cooked fish to avoid potentially harmful organisms [191]. However, pregnant women who have consumed "sushi grade" raw fish can be reassured that this is generally safe [192], as long as the raw fish was frozen appropriately [193], as this eliminates most parasites and bacteria. These women should be advised to discontinue future raw fish consumption. A variety of marine toxins (eg, ciguatoxin) can be ingested via fish consumption (cooked or raw), but there are only rare reports of adverse effects on pregnancy or the fetus. (See "Overview of shellfish and pufferfish poisoning".)

Fish may be contaminated by environmental pollutants, such as methylmercury. Methylmercury exposure, primarily through ingestion of contaminated fish, can cause severe fetal central

nervous system damage, as well as milder intellectual, motor, and psychosocial impairment. For this reason, the FDA and the Environmental Protection Agency recommend that pregnant women (or women who might become pregnant or who are nursing) should [191]:

- Avoid eating any shark, swordfish, king mackerel, marlin, orange roughy, tilefish (Gulf of Mexico), or bigeye tuna (other kinds of tuna are acceptable) because they may contain high levels of mercury (table 7).

- Eat two to three servings (8 to 12 oz total) per week of seafood that is likely very low in mercury or other contaminants ("best choices") **or** one serving of seafood (4 oz) that is likely low in mercury or other contaminants ("good choices") (table 7). Information on specific levels of methylmercury and other contaminants is available through the FDA food safety website and the EPA website.

- Check local advisories about the safety of fish caught in local lakes, rivers, and coastal areas.

The risks and benefits of fish consumption during pregnancy are reviewed in detail separately. (See "Fish consumption and marine omega-3 fatty acid supplementation in pregnancy".)

Caffeine intake — In a 2020 systematic review that included 42 findings from 37 observational studies, caffeine consumption was significantly associated with negative outcomes, including miscarriage, stillbirth, low birth weight, and small for gestational age [194]. Even moderate caffeine consumption (200 mg per day) appeared to be unsafe: The authors estimated that general consumption of 200 mg caffeine per day would account for approximately 350,000 negative pregnancy outcomes each year in the United States. These findings are contradictory to a 2017 systematic review that concluded that consumption of up to 300 mg caffeine per day in healthy pregnant women was generally not associated with adverse outcomes [195]. However, the effect of extraneous variables and possible misclassification of exposure and outcome variables remains a limitation of observational studies.

An American College of Obstetricians and Gynecologists (ACOG) Committee Opinion concluded that caffeine consumption <200 mg per day does not appear to be a major contributing factor in miscarriage or preterm birth [196]. A list of the caffeine content of beverages and foods is available in the table (table 8).

The effects of caffeine on pregnancy outcomes are discussed in detail separately. (See "The effects of caffeine on reproductive outcomes in women".)

Herbal products — We and others recommend avoiding herbal medicines and supplements during pregnancy [197-199], except for ginger (see "Nausea and vomiting of pregnancy: Treatment and outcome", section on 'Ginger'). The practitioner has no control over the strength or purity of the individual herbs; herbal preparations can interact with commonly prescribed medications and lead to dangerous side effects [200,201]; and several cases of potentially harmful effects to the pregnancy have been reported [202-205]. In the United States, makers of supplements are not required to prove efficacy, safety, or quality of a product before it is on the market, and numerous recalls of supplements have taken place due to product adulteration. (See "Overview of herbal medicine and dietary supplements", section on 'Regulation in the United States'.)

Consumption of herbal products is common. In the United States, 5 to 10 percent of pregnant women reported herbal intake during pregnancy [206,207] and 15 percent reporting using an herbal product or non-vitamin supplement, most commonly fish oil, melatonin, probiotics or prebiotics, acai, and cranberry [208]. Estimates of herbal intake have been higher in Europe and Australia, as high as 58 percent of pregnant women in one United Kingdom sample [209]. The most common products were herbal teas, chamomile, ginger, cranberry, raspberry leaf, echinacea, and ephedra.

There is a paucity of high-quality randomized trials evaluating the efficacy and safety of traditional herbal preparations in pregnancy [210]. In a 2016 Cochrane review that examined the effects of herbal medicines on miscarriage, none of nine randomized trials compared herbal medicines with either placebo or bedrest; thus, the authors concluded that there were insufficient data to make recommendations [211]. Some studies have reported lack of positive effects of herbal remedies [212], while others have reported negative effects on pregnancy and infant outcomes (eg, almond oil, licorice, and chamomile have been associated with preterm birth; raspberry leaf has been associated with cesarean delivery; mwanaphepo has been associated with maternal and neonatal morbidity) [199,213].

Consumption of liver-based foods — As discussed above, high consumption of liver or liver-based foods (eg, liver patties or sausage) may be harmful in pregnancy because of excessive intake of vitamin A. Some groups (eg, Finnish Food Safety Authority Evira, March of Dimes, National Health Service) have recommended that pregnant women limit or avoid liver consumption for this reason [91-96]. (See 'Adverse effects from excessive supplementation and dietary intake' above.)

Exposure to environmental toxins — ACOG has deemed reducing exposure to toxic environmental agents a critical area for intervention because of effects of toxins on the developing fetus [214]. Good nutrition is one way to buffer exposure to toxic agents [215,216].

Pregnant women should be encouraged to eat plenty of fruits and vegetables (either conventional or organic), legumes, and whole grains every day, and to avoid processed foods and fast foods.

Food can be a source of exposure to environmental toxins, such as bisphenol A (BPA) and pesticides. BPA is ubiquitous in food, particularly in the lining of canned goods. Exposure is a concern during pregnancy because of potential neural and behavioral effects in fetuses and infants. Women should be encouraged to avoid use of plastics for food and beverage containers that contain BPA, and avoid canned goods that use BPA linings (BPA-free canned goods are becoming increasingly available). (See "Occupational and environmental risks to reproduction in females: Specific exposures and impact", section on 'Bisphenol A and other phenols' and "Overview of occupational and environmental risks to reproduction in females", section on 'Interference with fetal development'.)

The effects of pesticide exposure from foods are unclear. The American Academy of Pediatrics recognizes that early pesticide exposure may adversely impact birth weight, risk of pediatric cancers, and cognitive function and behavior [217]. The Environmental Protection Agency sets a maximum residue limit, which is the amount of pesticide residue allowed to remain on each food or product [218]. This limit is set to ensure that "there is reasonable certainty of no harm." Much of the public, however, is still concerned about pesticides in food. A 2012 systematic review determined that consumption of organic foods may reduce exposure to pesticide residues and antibiotic-resistant bacteria [219]. On the other hand, organic foods have not been found to be nutritionally superior and tend to be more expensive and less accessible, particularly for vulnerable populations. (See "Overview of occupational and environmental risks to reproduction in females", section on 'Interference with fetal development'.)

MULTIPLE GESTATION

Nutritional requirements and weight gain recommendations are higher in multiple gestations. Guidelines are provided separately. (See "Triplet pregnancy", section on 'Weight gain' and "Twin pregnancy: Routine prenatal care", section on 'Gestational weight gain'.)

POSTPARTUM AND BREASTFEEDING

An adequate, balanced diet is important for replenishment of maternal stores that are expended during the pregnancy, for promoting loss of excess weight, and for nourishing the

breastfed infant. (See "Maternal nutrition during lactation" and "Overview of the postpartum period: Disorders and complications", section on 'Postpartum weight retention'.)

RESOURCES

- The Food and Information Center of the United States Department of Agriculture provides several online resources for pregnant women, including information on folic acid, food safety, foods to avoid, and nutrition.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: General prenatal care".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Nutrition before and during pregnancy (The Basics)" and "Patient education: Health and nutrition during breastfeeding (The Basics)" and "Patient education: Vegetarian diet (The Basics)")

- Beyond the Basics topic (see "Patient education: Maternal health and nutrition during breastfeeding (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- Nutrition is a key modifiable factor that affects birth outcomes and has long-term effects on the health of offspring. (See 'Introduction' above.)

- Patient nutrition risk and habits should be assessed early in pregnancy. Completion of a self-administered dietary questionnaire prior to seeing the clinician can be helpful (form 1 and table 2). Potential problems that require attention include (see 'Assessment of nutritional status' above):

  - Use of supplements
  - Food avoidances/special diets/skipping meals
  - Eating disorders
  - Lack of resources for adequate nutrition
  - Low intake of nutrient-dense foods (fruits and vegetables)
  - High intake of added sugars and fats (fried foods, processed foods, desserts)
  - Overweight or obesity
  - Medical history of bariatric surgery or other conditions that cause malabsorption
  - Substance misuse

- Consultation with a trained specialist in maternal nutrition, such as a registered dietitian, is recommended for women with high nutrition risk. (See 'Referrals' above.)

- The incidence of pregnancy complications is higher at the upper and lower extremes of weight gain. The National Academy of Medicine (formerly the Institute of Medicine [IOM]) recommendations for weight gain during singleton pregnancy are (see 'Prepregnancy weight and gestational weight gain' above):

  - Body mass index (BMI) <18.5 kg/m^2 (underweight) – weight gain 28 to 40 lbs (12.5 to 18.0 kg)

  - BMI 18.5 to 24.9 kg/m^2 (normal weight) – weight gain 25 to 35 lbs (11.5 to 16.0 kg)

  - BMI 25.0 to 29.9 kg/m^2 (overweight) – weight gain 15 to 25 lbs (7.0 to 11.5 kg)

  - BMI ≥30.0 kg/m^2 (obese) – weight gain 11 to 20 lbs (5 to 9.0 kg)

- The IOM and the Centers for Disease Control and Prevention recommend multiple-micronutrient (MMN) supplements (commonly called multivitamin supplements) for pregnant women who do not consume an adequate diet or may have malabsorption. Well-nourished women may not need MMN supplements, but in the absence of careful evaluation by a nutritionist, it is reasonable to recommend them. At a minimum, the daily

MMN supplement should contain key vitamins/minerals that are often not met by diet alone, such as (see 'Micronutrients' above):

- Iron – 27 mg
- Folate – at least 0.4 mg (0.6 mg in the second and third trimesters)
- Calcium – at least 250 mg (elemental calcium 1000 mg/day)
- Iodine – 150 mcg (preferably in the form of potassium iodide)
- Vitamin D – 200 to 600 international units (exact amount is controversial)

- Preconceptionally and during the first trimester, women should take a folic acid supplement of 0.4 to 0.8 mg/day. Higher doses (4 mg/day) are recommended for women known to be at increased risk for offspring with neural tube defects (eg, history of a previously affected infant, maternal use of some anticonvulsant medications). (See 'Folic acid' above.)

- Excessive intake of vitamin A (greater than 10,000 international units per day) and/or iodine can have harmful fetal effects. (See 'Adverse effects from excessive supplementation and dietary intake' above.)

- Women should be counseled to eat a healthy diet during pregnancy. This includes plenty of fruits and vegetables, whole grains, low-fat dairy, and a variety of proteins. Nutrient-dense foods should be encouraged, and empty calories should be minimized or avoided. These eating patterns will help women meet nutrient needs without exceeding calorie needs. "Eating for two" during pregnancy is a misnomer, as women require no additional calories during the first trimester and only a moderate increase in calories (additional 340 to 450 kcal/day) in the second and third trimesters. Exact needs vary among women based on age, prepregnancy weight, height, and activity level. Tools are available to help clinicians counsel women and for women to monitor their own nutrition. (See 'Counseling about healthy eating during pregnancy' above.)

- Self-imposed dietary restraints can be problematic if essential nutrients are left out of the diet or weight gain is inadequate. (See 'Counseling about common dietary concerns in pregnancy' above.)

- Certain foods should be limited or avoided during pregnancy because of potentially toxic effects. These include consumption of some types of fish, high caffeine intake, unwashed fruits/vegetables, unpasteurized dairy products, herbal products, liver-based foods, and undercooked meats. (See 'Counseling women about nutrition in pregnancy' above.)

- Patients should be educated about the risk for and prevention of foodborne infections. (See 'Avoidance of foodborne infections' above.)

- Pregnant women should limit seafood consumption to 12 oz of cooked seafood (approximately three 4 oz servings) per week, and completely avoid some types of seafood to minimize fetal exposure to mercury and other water-borne contaminants. Specific recommendations are described in the table (table 7). (See 'Fish consumption' above.)

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Topic 453 Version 124.0

GRAPHICS

Medical history that poses potential nutrition-related risks in pregnancy

Medical history or condition	Examples*
Diabetes	▪ Type 1 diabetes ▪ Type 2 diabetes
Obstetric history	▪ Previous child with neural tube defect ▪ Gestational diabetes ▪ Hyperemesis gravidarum ▪ Hypertensive disorder of pregnancy ▪ Current multifetal pregnancy
Inborn metabolic disorders	▪ Phenylketonuria ▪ Maple syrup urine disease
Surgical history	▪ Bariatric surgery ▪ Bowel resection
Gastrointestinal disease/conditions that cause malabsorption	▪ Crohn disease ▪ Ulcerative colitis ▪ Cystic fibrosis
Nutrition issues	▪ Obesity ▪ Overweight ▪ Eating disorder (past or current)
Unhealthy behaviors	▪ Use of cigarettes, alcohol, stimulants, illicit drugs

* Not an exhaustive list.

Graphic 107824 Version 1.0

Dietary questionnaire

What you eat and some of the lifestyle choices you make can affect your nutrition and health now and in the future. Your nutrition can also have an important effect on your baby's health. Please answer these questions by circling the answers that apply to you.

Eating behavior

1. Are you frequently bothered by any of the following? (circle all that apply)
   Nausea Vomiting Heartburn Constipation
2. Do you skip meals at least three times a week? No Yes
3. Do you try to limit the amount or kind of food you eat to control your weight? No Yes
4. Are you on a special diet now? No Yes
5. Do you avoid any foods for health or religious reasons? No Yes

Food sources

6. Do you have a working stove? No Yes
   Do you have a working refrigerator? No Yes
7. Do you sometimes run out of food before you are able to buy more? No Yes
8. Can you afford to eat the way you should? No Yes
9. Are you receiving any food assistance now? (circle all that apply)
   Food stamps School breakfast School lunch WIC
   Donated food Commodity supplemental food program
10. Do you feel you need help in obtaining food? No Yes

Food and drink

11. Which of these did you drink yesterday? (circle all that apply)

Soft drinks	Coffee	Tea	Fruit drink
Orange juice	Grapefruit juice	Other juices	Milk
Kool-Aid	Beer	Wine	Alcoholic drinks
Water	Other beverages (list) ______________________________		

12. Which of these foods did you eat yesterday? (circle all that apply)

Cheese	Pizza	Macaroni and cheese	
Cereal with milk	Yogurt		
Other foods made with cheese (such as tacos, enchiladas, lasagna, cheeseburgers)			
Corn	Potatoes	Sweet potatoes	Green salad
Carrots	Collard greens	Spinach	Turnip greens
Broccoli	Green beans	Green peas	Other vegetables
Apples	Bananas	Berries	Grapefruit
Melon	Oranges	Peaches	Other fruit
Meat	Fish	Chicken	Eggs
Peanut butter	Nuts	Seeds	Dried beans
Cold cuts	Hot dog	Bacon	Sausage
Cake	Cookies	Doughnut	Pastry
Chips	French fries	Deep-fried foods	Bread
Rolls	Rice	Cereal	Noodles
Spaghetti	Tortillas		

   Were any of these whole grain? No Yes

13. Is the way you ate yesterday the way you usually eat? No Yes

Lifestyle

14. Do you exercise for at least 30 minutes on a regular basis (three times a week or more)? No Yes
15. Do you ever smoke cigarettes or use smokeless tobacco? No Yes
16. Do you ever drink beer, wine, liquor, or any other alcoholic beverages? No Yes
17. Which of these do you take (circle all that apply)
    Prescribed drugs or medications
    Any over-the-counter products (such asaspirin, acetominophen, antacids, or vitamins)
    Street drugs (such as marijuana, speed, downers, crack, or heroin)

WIC: Women, Infants, and Children.

Graphic 53845 Version 3.0

Brief dietary assessment questionnaire

Over the past few months:	0 points	1 point	2 points
1. How many times a week do you eat fast food meals or snacks?	☐ Less than one time	☐ One to three times	☐ Four or more times
2. How many servings of fruit did you eat each day?	☐ Five or more	☐ Three to four	☐ Two or less
3. How many servings of vegetables did you eat each day?	☐ Five or more	☐ Three to four	☐ Two or less
4. How many regular sodas or glasses of sweet tea did you drink each day?	☐ Less than one	☐ One to two	☐ Three or more
5. How many times a week did you eat beans (like pinto or black beans), chicken, or fish?	☐ Three or more times	☐ One to two times	☐ Less than one time
6. How many times a week did you eat regular snack chips or crackers (not low-fat)?	☐ One time or less	☐ Two to three times	☐ Four or more times
7. How many times a week did you eat desserts and other sweets (not the low-fat kind)?	☐ One time or less	☐ Two to three times	☐ Four or more times
8. How much margarine, butter, or meat fat do you use to season vegetables or put on potatoes, bread, or corn?	☐ Very little	☐ Some	☐ A lot
Summary score (sum of all items) = ____			

Responses in the first points column indicate healthy eating habits (scored 0), responses in the second points column indicate less healthy eating habits (scored 1), and responses in the third points column indicate the least healthy eating habits (scored 2). Summary scores may range from 0 to 16, with lower numbers indicating good dietary habits and higher scores indicating poorer dietary habits.

Graphic 107808 Version 1.0

Recommended dietary allowances, or adequate intakes, and tolerable upper limits for adult pregnant and lactating women

	RDAs		ULs for pregnant and lactating women
	Pregnant women*	Lactating women*	
Fat-soluble vitamins			
Vitamin A	770 mcg	1300 mcg	3000 mcg
Vitamin D	600 international units (15 mcg)	600 international units (15 mcg)	4000 international units (100 mcg)
Vitamin E	15 mg	19 mg	1000 mg
Vitamin K¶	90 mcg	90 mcg	ND
Water-soluble vitamins			
Vitamin C	85 mg	120 mg	2000 mg
Thiamin	1.4 mg	1.4 mg	ND
Riboflavin	1.4 mg	1.6 mg	ND
Niacin	18 mg	17 mg	35 mg
Vitamin B6	1.9 mg	2 mg	100 mg
Folate	600 mcg	500 mcg	1000 mcg
Vitamin B12	2.6 mcg	2.8 mcg	ND
Minerals			
Calcium	1000 mg	1000 mg	2500 mg
Phosphorus	700 mg	700 mg	4000 mg
Iron	27 mg	9 mg	45 mg
Zinc	11 mg	12 mg	40 mg
Iodine	220 mcg	290 mcg	1100 mcg
Selenium	60 mcg	70 mcg	400 mcg

RDA: recommended dietary allowance; AI: adequate intake; UL: (tolerable) upper limit; ND: not determinable, due to lack of data of adverse effects and concern with regard to lack of ability to handle excess amounts.
* Females over 18 years old.
¶ The requirement for vitamin K is given as an AI rather than an RDA because there was insufficient scientific evidence to calculate the RDA.

Adapted from: Guidelines for Perinatal Care, sixth edition (2007); and Institute of Medicine Dietary Reference Intakes for Calcium and Vitamin D (2011), which can be accessed via www.nap.edu.

Graphic 60019 Version 9.0

Iron-rich foods

Food	Amount
Foods that provide 3 to 12 mg of iron	
Clams	4 large or 9 small
Oysters	6 medium
Octopus	3 oz cooked
Spinach	1/2 cup cooked
Lentils	1/2 cup cooked
Pumpkin seeds	1 oz roasted
Fortified cereals	1 cup
Foods that provide 1.6 to 3 mg of iron	
Sirloin steak	3 oz
Roast beef	3 oz
Lean hamburger	3 oz
Pork	3 oz
Lamb	3 oz
Salmon	3 oz
Tilapia	3 oz
Kidney beans	1/2 cup cooked
Lima beans	1/2 cup cooked
Navy beans	1/2 cup cooked
Oatmeal	1 cup cooked
Cashew nuts	1 oz dry roasted
Foods that provide 0.5 to 1.5 mg of iron	
Chicken	3 oz
Eggs	1 whole
Green peas	1/2 cup
Tomato juice	6 oz
Broccoli	1/2 cup
Brussels sprouts	1/2 cup cooked
Almonds	1 oz roasted
Peanuts	2 oz roasted
Dried apricots	5 halves
Raisins	1 oz (approximately 60 raisins)
Raspberries	1 cup
Strawberries	1 cup
Foods high in vitamin C that enhance iron absorption when consumed with iron-containing foods	
Broccoli	
Bell peppers	
Cantaloupe	
Grapefruit and grapefruit juice	

Kiwi
Orange and orange juice
Tomatoes and tomato sauces
Strawberries

mg: milligrams; oz: ounces.

Graphic 107826 Version 2.0

Selected food sources of folate and folic acid

Food	Micrograms (µg)
Breakfast cereals fortified with 100 percent of the DV, ¾ cup*	400
Beef liver, cooked, braised, 3 ounces	185
Cowpeas (blackeyes), immature, cooked, boiled, ½ cup	105
Breakfast cereals, fortified with 25 percent of the DV, ¾ cup*	100
Spinach, frozen, cooked, boiled, ½ cup	100
Great Northern beans, boiled, ½ cup	90
Asparagus, boiled, 4 spears	85
Rice, white, long-grain, parboiled, enriched, cooked, ½ cup*	65
Vegetarian baked beans, canned, 1 cup	60
Spinach, raw, 1 cup	60
Green peas, frozen, boiled, ½ cup	50
Broccoli, chopped, frozen, cooked, ½ cup	50
Egg noodles, cooked, enriched, ½ cup*	50
Broccoli, raw, 2 spears (each 5 inches long)	45
Avocado, raw, all varieties, sliced, ½ cup sliced	45
Peanuts, all types, dry roasted, 1 ounce	40
Lettuce, Romaine, shredded, ½ cup	40
Wheat germ, crude, 2 tablespoons	40
Tomato Juice, canned, 6 ounces	35
Orange juice, chilled, includes concentrate, ¾ cup	35
Turnip greens, frozen, cooked, boiled, ½ cup	30
Orange, all commercial varieties, fresh, 1 small	30
Bread, white, 1 slice*	25
Bread, whole wheat, 1 slice*	25
Egg, whole, raw, fresh, 1 large	25
Cantaloupe, raw, ¼ medium	25
Papaya, raw, ½ cup cubes	25
Banana, raw, 1 medium	20

* Items marked with an asterisk (*) are fortified with folic acid as part of the Folate Fortification Program.

Reproduced from: US Department of Agriculture, Agricultural Research Service 2003. USDA National Nutrient Database for Standard Reference, Release 16. Nutrient Data Laboratory Home Page, http://www.nal.usda.gov/fnic/cgi-bin/nut_search.pl.

Graphic 72855 Version 2.0

Weekly servings of fish to achieve 250 mg/day of EPA + DHA

Fish name	Number of 3.5 ounce (100 gram) servings*
Oily fish	
Anchovy, canned	1
Herring, Atlantic	1
Salmon, Atlantic	1
Tuna, bluefin	2
Mackerel, Atlantic	2
Bluefish	2
Trout, rainbow	2
Sardines, Atlantic canned	2
Striped bass	2
Tilefish¶	2
Swordfish¶	2
Tuna, albacore canned	3
Salmon, sockeye	3
Carp	4
Salmon, smoked (lox)	4
King mackerel¶	5
White fish	
Sea Bass	3
Pollock, Atlantic	4
Snapper	6
Flounder and sole	6
Tuna, light canned	7
Grouper	8
Catfish, wild	8
Halibut	8
Haddock	12
Cod, Atlantic	12
Shellfish	
Mussels	3
Crab, Alaska king	5
Oysters, eastern raw	6
Clams	7
Shrimp	7
Lobster, northern	10
Scallops	11
Crab, Blue	11

EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid.

* Servings rounded up to a whole number of servings.

¶ High in mercury. Pregnant women should avoid consuming these fish, as well as marlin, orange roughy, shark, and bigeye tuna. Refer to UpToDate topic on fish consumption in pregnancy.

Data from: United States Department of Agriculture (USDA) National Nutrient Database for Standard Reference. USDA website 2012. Available at: https://fdc.nal.usda.gov/. (Accessed July 16, 2020.)

Graphic 79454 Version 6.0

US Food and Drug Administration advice on fish consumption in women who are pregnant, might become pregnant, or are nursing

Best choices (eat 2 to 3 servings a week)		
Anchovy	Hake	Scallop
Atlantic croaker	Herring	Shad
Atlantic mackerel	Lobster (American and spiny)	Shrimp
Black sea bass	Mullet	Skate
Butterfish	Oyster	Smelt
Catfish	Pacific chub mackerel	Sole
Clam	Perch (freshwater and ocean)	Squid
Cod	Pickerel	Tilapia
Crab	Plaice	Trout (freshwater)
Crawfish	Pollock	Tuna, canned light (includes skipjack)
Flounder	Salmon	Whitefish
Haddock	Sardine	Whiting
Good choices (eat 1 serving a week)		
Bluefish	Monkfish	Tilefish (Atlantic Ocean)
Buffalofish	Rockfish	Tuna, albacore/white tuna, canned and fresh/frozen
Carp	Sablefish	Tuna, yellowfin
Chilean sea bass/Patagonian toothfish	Sheepshead	Weakfish/sea trout
Grouper	Snapper	White croaker/Pacific croaker
Halibut	Spanish mackerel	
Mahi mahi/dolphinfish	Striped bass (ocean)	
Choices to avoid (highest mercury levels)		
King mackerel	Swordfish	
Marlin	Tilefish (Gulf of Mexico)	
Orange roughy	Tuna, bigeye	
Shark		

One serving can be considered 3.5 ounces (100 grams). Note: On average, farm-raised fish tend to be lower in mercury compared with wild-caught fish[1].

Reference:

1. *Karimi R, Fitzgerald TP, Fisher NS. A quantitative synthesis of mercury in commercial seafood and implications for exposure in the United States. Environ Health Perspect 2012; 120:1512.*

Reproduced from: US Food and Drug Administration. Food: Eating Fish: What Pregnant Women and Parents Should Know. Available at: http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm393070.htm (Accessed January 26, 2017).

Graphic 111607 Version 5.0

Caffeine content in foods and beverages

Coffees	Serving size, oz (mL)	Caffeine, mg
Coffee, brewed	8 (235)	133 (range: 102 to 200)
Coffee, generic instant	8 (235)	93 (range: 27 to 173)
Coffee, generic decaffeinated	8 (235)	5 (range: 3 to 12)
Espresso	1 (30)	40 (range: 30 to 90)
Espresso decaffeinated	1 (30)	4
Teas	**Serving size, oz (mL)**	**Caffeine, mg**
Tea, brewed	8 (235)	53 (range: 40 to 120)
Arizona Iced Tea, black	16 (470)	32
Arizona Iced Tea, green	16 (470)	15
Nestea	12 (355)	26
Snapple, Just Plain Unsweetened	16 (470)	18
Snapple, Kiwi Teawi	16 (470)	10
Snapple, Lemon, Peach, or Raspberry	16 (470)	42
Starbucks Tazo Chai Tea Latte (Grande)	16 (470)	100
Soft drinks	**Serving size, oz (mL)**	**Caffeine, mg**
FDA official limit for cola and pepper soft drinks	**12 (355)**	**71**
7-Up, regular or diet	12 (355)	0
Barq's Diet Root Beer	12 (355)	0
Barq's Root Beer	12 (355)	22
Coke, regular or diet	12 (355)	35 to 47
Dr. Pepper, regular or diet	12 (355)	42 to 44
Fanta, all flavors	12 (355)	0
Fresca, all flavors	12 (355)	0
Jolt Cola	12 (355)	72
Mellow Yellow	12 (355)	53
Mountain Dew, regular or diet	12 (355)	54 (20 oz = 90)
Mountain Dew MDX, regular or diet	12 (355)	71 (20 oz = 118)
Mug Root Beer, regular or diet	12 (355)	0
Pepsi, regular or diet	12 (355)	36 to 38
Sierra Mist, regular or free	12 (355)	0
Sprite, regular or diet	12 (355)	0
TAB	12 (355)	46.5
Energy drinks	**Serving size, oz (mL)**	**Caffeine, mg**
5-hour ENERGY	2 (60)	215*
Amp	8.4 (250)	74
Cocaine	8.4 (250)	288
Enviga	12 (355)	100
Full Throttle	16 (470)	144
Glaceau Vitamin Water Energy Citrus	20 (590)	50

Monster Energy	16 (470)	160
Red Bull	8.3 (245)	80
Red Bull Sugarfree	8.3 (245)	80
Rip It, all varieties	8 (235)	100
Rockstar Energy Drink	8 (235)	80
SoBe Adrenaline Rush	8.3 (245)	79
SoBe Essential Energy, Berry or Orange	8 (235)	48
SoBe No Fear	8 (235)	83
Spike Shooter	8.4 (250)	300
Tab Energy	10.5 (310)	95
Frozen desserts	**Serving size, oz (mL)**	**Caffeine, mg**
Ben & Jerry's Coffee Ice Cream	8 (235)	68 to 84
Häagen-Dazs Coffee Ice Cream or Yogurt	8 (235)	58
Starbucks Coffee Ice Cream	8 (235)	50 to 60
Chocolates/candies/other	**Serving size, various units**	**Caffeine, mg**
Hershey's Chocolate Bar	1.55 oz (45 g)	9
Hershey's Kisses	41 g (9 pieces)	9
Hershey's Special Dark Chocolate Bar	1.45 oz (41 g)	31
Hot cocoa	8 oz (235 mL)	3 to 13
Powdered caffeine	1/16 tsp	200

FDA: US Food and Drug Administration; oz: ounce.
* Reported by Consumer Reports.

References:
1. *Harland BF. Caffeine and nutrition. Nutrition 2000; 16:522.*
2. *Juliano LM, Griffiths RR. Caffeine. In: Substance Abuse: A Comprehensive Textbook, Fourth Edition, Lowinson JH, Ruiz P, Millman RB, Langrod JG (Eds), Baltimore: Lippincott Williams, & Wilkins, 2005.*
3. *Center for Science in the Public Interest. Caffeine Content of Food and Drugs.*

Graphic 79304 Version 10.0

Contributor Disclosures

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Conflict of interest policy

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